

## RECIPROCATING COMPRESSOR

### RELATED APPLICATIONS

The present disclosure is related to subject matter contained in Korean Patent Application No. 2002-0054054, filed on September 7, 2002, which is expressly incorporating herein, by reference, in its entirety.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates to a reciprocating compressor, and particularly, to a reciprocating compressor which is configured to smoothly operate a suction valve by reducing a contact area between a piston and the suction valve.

#### 2. Description of the Background Art

Generally, a compressor is an apparatus for compressing refrigerant gas under the condition of low temperature and pressure, which is introduced from an evaporator and discharging the gas by changing the condition to high temperature and pressure.

The compressor can be classified as a rotary compressor, reciprocating compressor and a scroll compressor according to the method of compressing fluid.

Particularly, the reciprocating compressor sucks and compresses fluid while a piston moves linearly. A method of compressing in such a reciprocating compressor is divided into a method which compresses fluid by converting the rotary movement of a driving motor into a reciprocating movement of the piston,

and a method which compresses and sucks fluid by having the piston perform a reciprocating movement as the driving motor performs a linear reciprocating movement.

Figure 1 is a longitudinal sectional view showing a conventional reciprocating compressor, Figure 2 is a partially cross-sectional view showing an engagement of a piston and a suction valve in Figure 1 and Figure 3 is a partially longitudinal cross-sectional view showing a compression operation in Figure 1.

As shown in the drawing, the conventional reciprocating compressor includes a case 10 having a gas suction pipe SP and gas discharging pipe DP, and a frame unit 20 which is elastically installed inside the case 10. A reciprocating motor 30 is fixed to the frame 20 and has having a movable element which reciprocates linearly, a compression unit 40 is engaged to the movable element 33 of the reciprocating motor 30 and is supported by the frame unit 20. A resonance spring unit 50 for inducing resonating movement by elastically supporting the movable element of the reciprocating motor 30 in the movement direction is provided.

The compression unit 40 includes a cylinder 41 which is integrally formed in a front frame 21 of the frame unit 20, a piston 42 which is attached to the movable element of the reciprocating motor 30 for performing a reciprocating movement in a compression space P of the cylinder 41, a suction valve 43 which is mounted at the front end of the piston 42 for controlling suction of gas by opening and closing the suction path F of the piston 42, and a discharging valve assembly 70 which is mounted at the discharge side of the cylinder 41 for controlling discharge of gas by opening and closing the compression space P.

The discharging valve assembly 70 includes a discharge cover 71 for covering a side of the cylinder 41, and a discharge valve 72 which is located at the inner portion of the discharging cover 71 for elastically opening and closing the compression space P.

The suction valve 43 (Fig. 2) is formed as a circular thin plate and provided with a cutting groove 43a at the center thereof. The suction valve 43 is divided into a fixed portion 43b and an open/close portion 43c by the cutting groove 43a.

The suction valve 43 is fixed to an end portion surface 46 of the piston by a bolt B to be in contact therewith.

The operation process of the conventional reciprocating compressor with the above construction will be described as follows.

The piston 42 reciprocates in the cylinder 41 by a driving force of the reciprocating motor 30 and changes a volume of the compression space P, thereby sucking and compressing gas into the compression space P.

When the pressure of the gas is higher than a predetermined pressure, the discharge cover 72 of the discharging valve assembly 70 is opened and discharges the compressed gas, which process is sequentially repeated.

That is, when the piston 42 moves to a lower dead point (a), the discharge valve 72 of the discharging valve assembly 70 blocks the compression space P of the cylinder 41 and the open/close portion 43c of the suction valve 43 engaged to the piston 42 is bent, thereby opening the suction path F. At this time, gas is sucked into the compression space P of the cylinder 41 through the suction path F of the piston 42.

Then, as the piston 42 moves to an upper dead point (b), the suction valve 43 returns to an initial state and the suction path F of the piston 42 is closed, thereby compressing the gas sucked in the compression space P. When the pressure of the gas is higher than a predetermined pressure, the discharge cover 72 of the discharging valve assembly 70 is opened and the compressed gas is discharged.

Generally, to perform a smooth reciprocation of the piston, oil is provided between the suction valve 43 and an end portion surface 46 of the piston. However, in the conventional compressor, the suction valve 43 is temporarily adhered to the end portion surface 46 of the piston by viscosity of the oil.

As aforementioned, when the suction valve 43 is adhered to the end portion surface 46 of the piston, the suction path F is opened more later and more much, thereby degrading efficiency of the compressor.

#### SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide a reciprocating compressor which is configured to smoothly operate a suction valve by weakening adhesive force of oil by reducing a contact area between an end portion surface of a piston and a suction valve, and to reduce noise by a damping operation.

To achieve these and other advantages and in accordance with the purpose of the present invention, as embodied and as broadly described herein, there is provided a reciprocating compressor comprising: a piston which reciprocates in a compression space of a cylinder by being engaged with a reciprocating motor and

has a suction path connected to the compression space therein; a suction valve mounted at an end surface of the piston to control gas suction by opening and closing the suction path of the piston; a discharging valve assembly mounted at a discharge side of the cylinder to control gas discharge by opening and closing the compression space; and an adhesion preventing unit formed at a contact portion between the end portion surface of the piston and the suction valve to minimize adhesion due to oil by reducing a contact area between the piston and the suction valve.

The foregoing and other objects, features, aspects and advantages of the present invention will become more apparent from the following detailed description of the present invention when taken in conjunction with the accompanying drawings.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are included to provide a further understanding of the invention and are incorporated in and constitute a part of this specification, illustrate embodiments of the invention and together with the description serve to explain the principles of the invention.

In the drawings:

Figure 1 is a longitudinal sectional view showing the conventional reciprocating compressor;

Figure 2 is a disassembled perspective view showing an engagement of a piston and a suction valve of the compressor of Figure 1;

Figure 3 is a longitudinal sectional view showing a suction operation of

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the compressor of Figure 1;

Figure 4 is a longitudinal sectional view showing a compression operation of the compressor of Figure 1;

Figure 5 is a longitudinal sectional view showing a reciprocating compressor according to one preferred embodiment of the present invention;

Figure 6 is a disassembled perspective view showing an engagement of a piston and a suction valve of the compressor of Figure 5;

Figure 7 is a longitudinal sectional view showing a suction operation of the suction valve of the compressor of Figure 5;

Figure 8 is a longitudinal sectional view showing a compression operation of the suction valve of the compressor of Figure 5;

Figure 9 is a frontal view showing an end portion surface of the piston of the compressor of Figure 5;

Figure 10 is a disassembled perspective view showing an engagement between the piston and the suction valve according to another preferred embodiment of the present invention.

Figure 11 is a longitudinal sectional view showing an engagement between the piston and the suction valve of the compressor of the embodiment of an engagement between the piston and the suction valve of Figure 10; and

Figure 12 is a longitudinal sectional view showing a reciprocating compressor according to still another preferred embodiment of the present invention.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

Figure 5 is a longitudinal sectional view showing a reciprocating compressor according to one preferred embodiment of the present invention, Figure 6 is a disassembled perspective view showing an engagement of a piston and a suction valve of Figure 5, Figure 7 is a longitudinal sectional view showing a suction operation of the piston of Figure 5, Figure 8 is a longitudinal sectional view showing a compression operation of Figure 5, and Figure 9 is a frontal view showing a piston end surface portion of Figure 5.

As shown, the reciprocating compressor according to the present invention includes a case 10 having a gas suction pipe SP and a gas discharging pipe DP, a frame unit 20 which is elastically installed inside the case 10. A reciprocating motor 30 is fixed to the frame 20, and has having a movable element (not shown) which linearly reciprocates, a compression unit 140 engaged to the movable element of the reciprocating motor 30 and is supported by the frame unit 20, and a resonance spring unit 50 for inducing resonating movement by elastically supporting the movable element of the reciprocating compressor 30 in the movement direction are provided.

The compression unit 140 includes a cylinder 141 which is integrally formed with the frame unit 20, and a piston 142 which is secured for movement with the movable element of the reciprocating motor 30 for performing a reciprocating movement in a compression space P of the cylinder 141. A suction valve 143 is mounted at the front end of the piston 142 for controlling the suction

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of gas by opening and closing the suction path F of the piston 142, and a discharging valve assembly 170 is mounted at the discharge side of the cylinder 141 for controlling discharge of gas by opening and closing the compression space P.

The piston 142 includes a head portion 145 (Fig. 6) having a predetermined length and which is inserted to an inner portion of the cylinder 141, an end portion surface 146 of the piston formed at an end portion of one side of the head portion 145 and defining a predetermined space P, and a connecting portion 147 formed with a predetermined area extending perpendicularly to the longitudinal direction and configured to be connected to the movable element of the motor at the side opposite the head portion 145.

The suction path F along which gas flows is formed within the head portion 145 and extends to the end portion surface 146 of the piston.

The discharging valve assembly 170 includes a discharge cover 171 for covering a compression space P of the cylinder 141, and a discharge valve 172 which is located within the discharging cover 171 for elastically opening and closing the compression space P.

The suction valve 143 is formed as a circular thin plate and provided with a cutting groove 143a at the center thereof. The suction valve 143 is divided into a fixed portion 143b and an open/close portion 143c by the cutting groove 143a. The suction valve 143 is fixed to an end portion surface 146 of the piston by a bolt B.

That is, in performing suction, the suction valve 143 opens the flow path F by a pressure difference, and in performing operating compression, the suction valve 143 closes the flow path F by the pressure difference.



In the present invention, an adhesion preventing unit is formed at a contact portion of the end portion surface 146 of the piston and the suction valve 143 in order to minimize the viscous effect of the oil by reducing the contact area of the surface 146 with the suction valve 143.

The adhesion preventing unit can be formed one side of either the end portion surface 146 of the piston the suction valve 143. The adhesion preventing unit can also be formed at both sides thereof.

As shown in Figures 5 to 9, in the reciprocating compressor according to one preferred embodiment of the present invention, an adhesion preventing groove 146a comprises a dent or depressed area with a predetermined depth at the end portion surface 146 of the piston which serves as the adhesion preventing unit.

A depth of the adhesion preventing groove 146a is determined so as not to influence the viscosity of the oil, which is preferably formed to be about 20-200 $\mu$ m.

Also, an oil back flow preventing protrusion 146b (Figs. 8 and 9) is formed at the end portion of the suction path F located at the end portion surface 146 of the piston so as to prevent back flow of the oil, which has flowed into the adhesion preventing groove 146a to the suction path F.

The oil back flow preventing protrusion 146b is formed on the same vertical surface as the end portion surface 146 of the piston so as to selectively open and close the suction path F by the suction valve 143.

Figure 10 is a disassembled perspective view showing an engagement between the piston and the suction valve according to another preferred embodiment of the present invention.

Figure 11 is a longitudinal sectional view showing a reciprocating compressor of Figure 10. As shown, the adhesion preventing groove 156a comprises a dent or depression with a predetermined depth that is formed at the end portion surface 146 of the piston to prevent adhesion according to another preferred embodiment of the present invention. The adhesion preventing groove 156a is partially formed at the upper side of the end portion surface of the piston 146.

The reason for the formation of the groove 156a is in order to provide timely opening of the suction path F by the suction valve 143 at the time of a suction operation and to tightly close the suction path F without gas leakage by the suction valve 143 at the time of a compression operation.

A depth of the adhesion preventing groove 156a is determined within a range which does not influence the viscosity of the oil. The depth is preferably formed to be about 20-200 $\mu$ m.

Also, an oil back flow preventing protrusion 156b is formed at the end portion of the suction path F located at the end portion surface 146 of the piston so as not to prevent back flow of the oil which has flowed into the adhesion preventing groove 156a to the suction path F.

The oil back flow preventing protrusion 156b is formed on the same vertical surface as the end portion surface 146 of the piston so as to selectively open and close the suction path F by the suction valve 143.

Figure 12 is a longitudinal sectional view showing a reciprocating compressor according to still another preferred embodiment of the present invention.

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As shown, the adhesion preventing groove 166a is formed in the suction valve 143 in another preferred embodiment of the present invention.

A depth of the adhesion preventing groove 166a is preferably formed to be about 20-200 $\mu$ m.

Hereinafter, operations of the reciprocating compressor according to one preferred embodiment will be explained.

The piston 142 reciprocates in the cylinder 141 by a driving force of the reciprocating motor 30 and changes a volume of the compression space P, thereby sucking and compressing gas into the compression space P.

When the pressure of the gas is higher than a predetermined pressure, the discharging valve assembly 170 is opened and discharges the compressed gas and this operation is sequentially repeated.

That is, when the piston 142 moves to a lower dead point (a) as shown in Fig. 7, the discharging valve assembly 170 closes the compression space P of the cylinder 141 and the open/close portion 143c of the suction valve 143 engaged to the piston 142 is bent, thereby opening the suction path F. At this time, gas is sucked into the compression space P of the cylinder 141 through the suction path F of the piston 142.

In the present invention, the adhesion preventing groove 146a is formed at the end portion surface 146 of the piston 142, so that the suction valve 143 has less contact area with the end portion surface 146 of the piston.

That is, since the viscous force of the oil is proportional to the contact area, the suction valve 143 is not influenced by the viscous force of the oil but can open the suction path F in a timely manner.

Then, when the piston 142 moves to an upper dead point (b) as shown in Fig. 8, the suction valve 143 returns to an initial state and the suction path F of the piston 142 is closed, thereby compressing the gas sucked into the compression space P. When the pressure of the gas is higher than a predetermined pressure, the discharge cover 172 of the discharging valve assembly 170 is opened and discharges the compressed gas.

When the suction operation is converted to the compression operation, the bent open/close portion of the suction valve 143 returns to the initial state and is damped by the oil in the adhesion preventing groove 146a. That is, by reducing the contact area of the open/close portion 143c of the suction valve 143 and the end portion surface 146 of the piston, chattering noise can be reduced.

As aforementioned, in the present invention, since the suction valve 143 is opened timely by reducing the viscosity force of the oil, the compression performance is increased and a reliability of the device is improved.

Also, in the present invention, the chattering noise generated by a contact of the piston 142 and the suction valve 143 can be reduced by damping the suction valve 143.

As the present invention may be embodied in several forms without departing from the spirit or essential characteristics thereof, it should also be understood that the above-described embodiments are not limited by any of the details of the foregoing description, unless otherwise specified, but rather should be construed broadly within its spirit and scope as defined in the appended claims, and therefore all changes and modifications that fall within the metes and bounds of the claims, or equivalence of such metes and bounds are therefore intended to

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be embraced by the appended claims.